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ABSTRACT

Designed to help institutional researchers transform data into useful information, this paper discusses principles for presenting research results to administrators in the top levels of management. The first section describes ten fundamental principles of data presentation: knowing what information is needed; knowing when the information is needed; matching the format to the sophistication and preferences of the audience; focusing on only one or two issues in each presentation; including a brief summary; keeping the language simple; using graphics sparingly and correctly; integrating tables into the text; occasionally using mnemonics or analogies to make points; and repeating major findings in subsequent communications. The next section compares the value of graphs and charts, arguing that the decision to present information in tables as opposed to graphs must depend upon what the user wishes to accomplish. Next, criteria for designing effective tables are discussed, including the importance of making the table self-explanatory and unambiguous, specifying all sources and units, making sure the arrangement facilitates logical analysis, rounding numbers to significant digits, and ranking rows and columns by size of numbers instead of alphabetically. Next, several principles to ensure that graphics tell the truth about data are presented, including keeping the representation of numbers in graphs directly proportional to their actual numeric value; labeling graphs clearly and thoroughly; showing data variation as opposed to design variation; and refraining from quoting data out of context. Finally, the paper reviews various types of graphic presentations, concluding that horizontal bar and line/column charts are generally more effective than pie charts, segmented bars and graphs, or three-dimensional graphs; and recommending caution in the use of pictorial and logarithmic charts. The paper focuses on the fundamental principles of written reports and oral presentations. In conclusion, the paper hopes to improve the effectiveness and reputation of institutional research through stimulating self-examination. (JMC)

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THE PRESENTATION AND INTERPRETATION OF DATA TO MANAGEMENT

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THE INTERPRETATION AND PRESENTATION OF DATA TO MANAGEMENT

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While people may often use statistics the way drunks use lampposts--more for support than illumination--it is the hope and assumption of most institutional researchers and planning analysts that their work enlightens decisionmakers, leading to better decisions. But this outcome is unlikely if the data secrets remain buried in computer files or "green bar" printouts. Transforming data into useful information is both an art and a science--and an essential skill for the effective institutional researcher.

In part, the challenge is to present research results in formats and at a level of sophistication accessible to top management. Few top administrators can afford the luxury of studying in detail the numerous statistical reports generated by a productive institutional research office. The comprehensiveness of an environmental scan may be the pride of the planner but only a few findings have the chance to influence institutional decisions. The research or planning professional must devise ways of improving the odds that study insights and findings will be assimilated into the decisionmakers' frame of reference.

Fundamental Principles

The basic problem was stated by William Playfair in 1801:

> For no study is less alluring or more dry and tedious than statistics, unless the mind and imagination are set to work or that the person studying is particularly interested in the subject; which is seldom the case with young men in any rank in life. (Quoted in Fienberg, 1979, p. 165).

Since this is probably still the case nearly two centuries later, institutional researchers need to know how to convey statistical information to those not statistically inclined. Statistical data may be presented in text, tables, or graphs. Each method has its advantages and disadvantages, which will be discussed below. First, however, I present ten fundamental principles of data presentation that can contribute to more effective institutional research:

Know what information is needed. The most fundamental principle of all; research that is perceived as irrelevant represents wasted effort and can place your very function at risk. The institutional researcher or planner should be in the top management communications loop, preferably on the president's cabinet, college planning council, or equivalent. If this isn't possible, ensure through other means that you are kept informed so that project priorities and research designs are chosen to maximize their utility to decisionmakers. Note that this means more than being responsive to requests; decisionmakers may not know enough to ask for data that may be useful to them. The effectiveness of, and respect given, institutional research can increase when it provides information unasked for but pertinent to the task at hand.

Know when the information is needed. Timing isn't everything but it's close. Your analysis won't have much influence on a decision that was made yesterday. It's best to be proactive and have the information prepared before it's needed, and then time its presentation to coincide with the beginning of deliberations of decisionmakers. However, since it's impossible to anticipate all the possible paths decisionmakers' thinking may lead, maintaining a readily-accessible database for quick responses to late-breaking requests is also necessary. This would include an office library of reference materials as well as computer access to student and other data files.

Match format to analytical sophistication and learning preferences of recipients. As Meredith (1989) has argued, "Use the least sophisticated tool to make your case. Don't get wrapped up in procedures when results and trends are the most important product." Presidents and trustees may not appreciate statistical pyrotechnics if they cannot understand them. While you should obviously use the most appropriate tool based on your judgment as a research professional, present the findings in ways accessible to your audience. If you lose people in long discussions of your methodology, the valuable insights you may have discovered may be lost as well.

Focus on one or two research questions or conclusions. While this principle is particularly applicable to oral presentations, it often is a good guideline for written reports as well. A series of brief reports, each devoted to one or two issues, will often be more effective than one large, comprehensive study. At times, however, a report will necessarily be lengthy. This leads to the next principle:

Include a brief summary. An executive summary is not only a courtesy to your reader, but may mean the difference between your study being read or not being read. A large report lacking a summary may not be read at all; with an overview up front to spark interest, it may be read in full. At the very least, the

reader will learn the major findings from reading the summary.

Eschew obfuscation! To avoid confusing your audience, keep your language as simple and direct as possible. You may have no choice but to use sophisticated, even arcane, techniques, if the task calls for them, but you need to discuss them and their results in common terms. For most applications, you will want to avoid the jargon of your discipline. Reread your Strunk and White, and Edwin Newman's Strictly Speaking! As Thomas Jefferson said, "The most valuable of all talents is that of never using two words when one will do." Most of us can benefit from a refresher course in technical writing, and all our readers will benefit from our adherence to the KISS principle. This principle of using simple, direct language would improve our professional journals as well.

Use graphics sparingly and correctly. The selective use of graphics can be a great communications aid, but they must be used with discrimination and precision. The ease of graphing produced by readily available microcomputer software has caused the proliferation of graphs in institutional research applications, often compounding the problem of information overload and reducing the effectiveness of communication. The untutored can easily create misleading graphics, and even the skilled often use too many of them.

Integrate tables and graphics into text or presentation. Avoid having page after page of tables or graphs with no text, or data separated from text so that the reader constantly has to interrupt his or her flow to "See table X" located on another page, or worse still, in an appendix. As Tufte (1983, p.181) says,

> Data graphics are paragraphs about data and should be treated as such....Imagine if graphics were replaced by paragraphs of words and those paragraphs scattered over the pages out of sequence with the rest of the text--that is how graphical and tabular information is now treated in the layout of many published pages.

While in some cases extensive appendices of data may be appropriate, pull out key data referred to in the text and place these data abstracts directly in the textual flow. This will require selectivity or what Norris (1983) has called "triage and the art of institutional research;" he reinforces his point that unessential supporting data should be omitted by saying that if you try to influence management "with a thirty-page report, supported by three technical appendices, all that this author can do is wish you good luck in your new job--whatever and wherever it might be" (p. 169).

Consider infrequent use of analogies, mnemonics, or other verbal aids. The key word is infrequent; a reputation for excessive cuteness will ruin credibility. However, the occasional use of catchy phrases can be effective. For example, "it takes two 40-year-olds to equal one 18-year-old" will get laughs but also make the point that FTEs will fall with a one-to-one replacement of declining high school graduates with older "returning adults." The catchy phrase works where a table of average credit hour loads by age cohort may not.

Repeat major findings in subsequent communications when opportune. The active life of much institutional research in decisionmakers' minds can be very short--an answer to an immediate question is often quickly forgotten. This is unwarranted in many cases; the insights of solid research could continue to be useful guides to decisionmaking. Look for opportunities to restate research findings, especially when they go against the conventional wisdom. Use previous findings when pertinent to new studies and build institutional knowledge. In your monthly activity reports, instead of just listing projects completed, include a sentence or two summarizing what was learned.

Tables Versus Graphs

Data may be discussed in text, presented in tables, or displayed in graphs. Text allows for interpretation, and may be most accessible to the broad audience. Tables are best when exact numerical values need to be communicated, and when many localized comparisons are to be made. Graphs can communicate trends powerfully, and reveal relationships in the data that would remain hidden in tables. William Playfair, a pioneer in graphical design, wrote in 1786:

> Information, that is imperfectly acquired, is generally as imperfectly retained; and a man who has carefully investigated a printed table, finds, when done, that he has only a very faint and partial idea of what he has read; and that like a figure imprinted on sand, is soon totally erased and defaced....Charts...while they give a simple and distinct idea...are as near perfect accuracy as is any way useful. On inspecting any one of these charts attentively, a sufficiently distinct impression will be made, to remain unimpaired for a considerable time, and the idea which does remain will be simple and concrete. (Quoted in Tufte, p. 32.)

The use of graphs in institutional research has expanded rapidly in the recent past, spurred on by user-friendly software. Despite claims by vendors that the use of computer graphics will improve decision speed and quality over traditional methods of

data display, the available evidence is more mixed than supportive; indeed, in contrast to Playfair's assertions, research suggests graphs may be no better than tables as an information presentation method (DeSanctis, 1984). Features that make a graph visually attractive, such as color, design complexity, and realism, may detract from accurate comprehension. The ability to use graphs effectively varies across individuals, so an overreliance on graphical displays may inhibit understanding and effective communication.

DeSanctis' review of the literature of studies directly comparing tabular and graphic presentation revealed conflicting results. Some studies found tables superior to graphs, others the opposite. Omitting findings of simple user preference, which were evenly split between tables and graphs, and focusing on more specific dependent variables, DeSanctis's classificatory summary found tables better than graphs more often then the reverse:

Summary of Research Results Comparing Graphs and Tables for Selected Dependent Variables (Number of Studies)

Variable	Better with Graphs	Better with Tables	No Difference
Interpretation accuracy	2	4	1
Interpretation speed	1	1	-
Decision-making quality	1	3	3
Decision-making speed	1	1	2
Decision-making confidence	-	1	2
Information recall	-	-	2
Totals	5	10	10

(Adapted from DeSanctis, 1984, p. 475.)

Acknowledging the limitations of the above classification and counting scheme, which takes no account of variation in the merit of the various studies reviewed, it seems apparent that no consensus exists on the tables versus graphs debate. It is likely, as DeSanctis (p. 475) suggests, that "the best method of data display may vary as a function of the task to be accomplished by the user."

Principles of Tabular Design

Tables will continue to be the most common mode of data display in institutional research because actual data values will continue to be wanted by decisionmakers, even if only in supporting or verification roles. Tables are compact and exact

but their abstractness requires an educated reader. As MacDonald-Ross (1977) has pointed out, "Even quite sophisticated people need time to get the main points from a table (often much more time than they would need with a bar chart or pictorial chart) and less educated people often cannot read tables at all" (pp. 378-379). Proper table design can ease the difficulty. Over a half century ago, Walker and Durost (1936) provided a checklist of criteria every table should meet:

1. Is it logically a unit, all the data closely related, with no extraneous facts included?

2. Is it autonomous, self-explanatory, self-sufficing? Can it stand alone if removed from the context?

3. Is the title unambiguous, concise, complete, clear, and logically accurate?

4. Are sources and units specified?

5. Does every column and every row have a heading? Are these well chosen? Does the column heading, taken with any box headings to which it is subordinate, name that which stands in the column?

6. Are all subclassifications logically subordinate to the main classification?

7. Does the arrangement facilitate logical analysis?

A.S.C. Ehrenberg (cited in MacDonald-Ross, 1977) has shown that table design can be improved by adhering to a few simple principles:

1. Round numbers to two significant digits to facilitate mental arithmetic.

2. Provide row and/or column averages for reference points.

3. Use columns for most important comparisons.

4. Rank order rows and columns by size of numbers, not alphabetical order of labels.

5. Set columns and rows compactly--do not artificially space out to fill the page. Space can be used to distinguish blocks of related data.

Ehrenberg's first principle is routinely violated in institutional research reports, but is worthy of consideration. Is rounding to two digits really "losing data" or simply a way of eliminating spurious precision? Rounding errors are usually

trivial in effect, and the positive advantage of eliminating the extra digits is that "we can see, manipulate, and communicate two-digit numbers better" (MacDonald-Ross, p. 379).

Principles of Graphic Design

Simply because creating attractive graphs is now an easy task does not imply that creating effective graphs is easy. As Schmid and Schmid (1979) state, "no amount of sophistication in computer technology alone is a substitute for genuine understanding and expertise in the theory and practice of graphic presentation" (p. 12). They assert the widespread existence of "graphic illiteracy" (p. 11):

> The preparation of statistical charts is not a perfunctory, mechanical procedure; rather, it involves conceptual logic and other basic principles....An effectively designed chart is tantamount to a visual statement, not infrequently equivalent to many paragraphs or even many pages of written words....Although statistical charts are often a more powerful and significant vehicle of communication than words, there is a strange tolerance for poorly constructed charts. Paradoxically, the reader who is outraged by an ungrammatical sentence, an ambiguous statement, or even misplaced punctuation marks may be quite tolerant or indifferent to crudely designed, idiosyncratic, inappropriate, or confusing charts. This situation is essentially reflective of the graphic illiteracy not only of the reader but also of those responsible for the preparation of poorly designed and executed charts.

MacDonald-Ross concurred, saying that "the researcher will soon discover that most practitioners are more or less incompetent!" (p. 403). Incompetence and intentional deception produce graphics that "lie," so Tufte (1983, p. 77) developed six principles of graphical integrity to ensure that graphics tell the truth about the data:

1. The representation of numbers, as physically measured on the surface of the graphic itself, should be directly proportional to the numerical quantities represented.

2. Clear, detailed, and thorough labeling should be used to defeat graphical distortion and ambiguity. Write out explanations of the data on the graphic itself. Label important events in the data.

3. Show data variation, not design variation.

4. In time-series displays of money, deflated and standardized units of monetary measurement are nearly always better than nominal units.

5. The number of information-carrying (variable) dimensions depicted should not exceed the number of dimensions in the data.

6. Graphics must not quote data out of context.

Tufte's book should be read by anyone interested in graphical displays of data, for the enjoyment as well as the enlightenment it provides. In addition to not distorting the data, graphical excellence for Tufte consists of communicating complex, usually multivariate, ideas with clarity, precision, and efficiency, summed up in his principle (p. 51):

> Graphical excellence is that which gives to the viewer the greatest number of ideas in the shortest time with the least ink in the smallest space.

Tufte's idea, that most of a graphic's ink should vary in response to data variation, underlies his theory of data graphics and leads to some experimental designs that, at the least, would take some getting used to. Until they are included in popular graphics software packages, most institutional researchers will continue to use the traditional formats.

Graph Purposes, Types, and Effectiveness

Graphics for presentation purposes usually have one of the following purposes: to show component proportions, item magnitudes, trends or time series, frequency distributions of items over ranges, or relationships between variables. (Graphics can also be used for analysis; Tukey's 1977 book is the seminal work on exploratory data analysis through graphing.) The traditional graph types include pie, bar, column, line, and dot, and the choice of each is dependent on the kind of comparison you want to show.

While your purpose should determine the type of graph you select, research and experience suggest some types are more effective than others:

Horizontal bar charts. Several authors, including MacDonald-Ross (p. 401) and Zelazny (p. 26), argue that horizontal bars deserve broader usage due to their versatility and effectiveness, especially for showing item comparisons. Deviations, correlations, and the mix of two components can also be shown with horizontal bars using both sides of the vertical axis.

Line and column charts. Effective, reliable workhorses for showing time series and frequency distributions.

Several common graphical forms are denounced by researchers into the graphical display of statistical data. Among those condemned are:

Pie charts. Most people have difficulty making fine distinctions between angles. Pie charts with more than four segments are especially problematic. Tufte is emphatic: "A table is nearly always better than a dumb pie chart; the only worse design than a pie chart is several of them, for then the viewer is asked to compare quantities located in spatial disarray both within and between pies" (p. 178). I agree that multiple pies are to be avoided, but the occasional use of individual pies with four or fewer segments can sometimes be condoned.

Segmented bars and graphs. Segmented or stacked bar graphs lose the common reference line and make comparisons difficult among all but the bottom segment and should generally be avoided. Segmented area graphs are even more difficult to comprehend.

Three-dimensional graphs. MacDonald-Ross's review of the literature led him to state that "segmented graphs and three-dimensional forms (that represent quantity by volume) should never be used" (p. 401). When they have more dimensions than the data, three-dimensional graphs confuse the viewer and impede communication.

Other graphical forms receive mixed reviews and should be used with caution:

Chloropleth maps. Chloropleth maps show geographic areas of equal value on the variable investigated by the same color, hatching, or shading. They are useful for geographic analysis, where location is paramount, but they can be misleading since they equate the visual importance of a geographic area with the value of the variable being displayed, or as Tufte puts it, "Our visual impression of the data is entangled with the circumstance of geographic boundaries, shapes, and areas" (p.20).

Pictorial charts. Pictorial charts use icons or symbols associated with the subject matter to show quantity and are thus less abstract than other charts and more accessible to the general reader. The only acceptable pictorial chart is that which repeats identical symbols of the same size to reflect quantities. Those that change width as well as height to maintain pictorial proportions will distort the data, unless carefully designed to reflect the data change by area, a difficult and infrequent practice. Tufte shows several examples of how the "confounding of design variation with data variation" leads to "ambiguity and deception, for the eye may mix up changes

in the design with changes in the data" (p. 61). Huff (1954) and Spear (1969) also point out intended and innocent examples of misleading pictographs. In general, pictorial charts, though perhaps more accessible to the masses, should not be used for educated audiences.

Semi-logarithmic and logarithmic charts. Used to show relative change of variables expressed in different units, or when baseline quantities differ greatly, semi-log charts should only be used with audiences educated in their use. Full logarithmic charts have both axes divided logarithmically. While useful for showing rates of change as opposed to amounts of change, log charts should never be used with a lay audience.

In addition to the pros and cons of individual graph types, the mix of graphs used in a report or presentation should be carefully considered. Page after page, slide after slide, of the same graph type should be avoided; the monotony destroys effective communication. The fundamental principle that graphs should be used sparingly for emphasis or to reveal relationships generally holds. When many graphs are to be used, a variety should be used to aid audience attention, if the data and purpose allow. Zelazny (1985, p. 26) recommends a mix of 50 percent column and line graphs, 25 percent horizontal bars, 10 percent dot or scatterplot, 5 percent pie charts, with the remainder combination graphs. This recommended mix varies from common practice, where pies are most frequent and horizontal bars underused.

Finally, a word about color. Color can suggest frivolous expense in printed publications, and may detract from effective communication if used in an unthinking manner. If a chart does not communicate well in black and white, color is not going to help (Zelazny, p. 80). Color should be used for a purpose, not as decoration. For example, color can be used to highlight the key part of a graph, to identify a recurring theme in a series of charts, or to distinguish actual from projected data.

Written Reports

In most instances, the fundamental principles discussed at the beginning of the paper apply to the preparation of written reports. Short, concise research briefs focussed on one or two research questions are usually more effective than long, comprehensive treatises when trying to influence busy decisionmakers. The standard format of executive summary, introduction and background, method and limitations, findings, conclusions, and appendices is appropriate for more formal reports, especially if they concern highly visible or controversial policy decisions. Technical appendices may lend credibility, and be read by an unseen audience of advisors to top management.

Writing is an art and skill that improves with practice. Make a habit of writing up short technical memos or research briefs to capture the insights of small data requests. A few words of interpretation can avoid misuse of data by others. As they accumulate, you build an office reference library helpful in responding to future requests.

Finally, consider preparing reports for publication in the professional literature. As an earlier Professional File (Ruggiero, et al., 1985) argued, "If we don't write--more and better--to each other, many of us are likely to remain number crunchers and file makers--discovering, but failing to interpret and communicate."

Oral Presentations

The principles of good speech communication apply to the oral presentation of data and research findings. The presentation should have a structure, starting with an introduction to catch attention, orient the audience to the subject, and establish rapport. The purpose of the presentation should be clearly established. The body of the speech should contain transitional statements to promote a smooth, logical flow. The presentation should conclude with a brief summary and a strong final point. To overcome shyness or reticence, focus on your message and think of public speaking as simply an enlarged conversation. Vary your pitch and intensity to emphasize what is important. Use a few visual aids for emphasis, not a lot as a crutch. Basically, know your material, be prepared, and apply the fundamental principles!

Conclusion

How research and planning data and findings are presented to management largely determines how effective they are in influencing decisionmaking. The usefulness of the product reflects on the value of the producer. Institutional researchers should carefully evaluate how well they perform the data-to-information transformation. It is hoped that this paper can serve to stimulate such self-examination, with the goal of improving the effectiveness and reputation of institutional research.

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